
# *Computer Networks & Software Inc.*

*Accelerating CNS*

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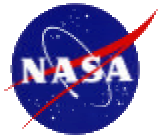


# *Demonstration of the NASA Small Aircraft Transportation System (SATS) Airborne Internet (AI)*

**I-CNS Conference 2002**

7405 Alban Station Court, Suite B201, Springfield, Virginia 22150-2318 (703) 644-2103

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# Agenda

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- **Project Overview/Results**
- **Testbed/demonstration platform description**
- **Demonstration**

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# *SATS AI Project Summary*

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- **NASA GRC SATS CNS: Denise Ponchak**
- **NASA GRC Program Manager: Mike Zernic**
- **Project:**
  - **Develop the requirement, architecture, and system level design baselines,**
  - **and establish the evaluation testbed for the Airborne Internet.**
- **AI Objective:**
  - **Consolidate and integrate the exchange of CNS data.**
  - **Minimize the number of radios and antennas on an aircraft. Goal is to provide common access means for all wireless aircraft applications.**

# *Who are we?*

## NASA GRC Team

- **Computer Networks & Software, Inc. (CNS) - Prime**
  - **Mulkerin Associates Inc. (MAI)**
  - **AvCS Research Ltd.**
  - **Microflight, Inc.**
  - **Project Management Enterprises, Inc. (PMEI)**
  - **AvCom, Inc.**
  - **Comptel, Inc.**
- **Architecture Technologies Corporation**

**Accomplished the first project cycle to define the SATS AI**

# What is SATS?

## SATS Program Objectives

- **Concept: Add mobility and economic growth to communities - by increasing smaller airport capacity**
- **Objectives:**
  - **Higher volume operations in non-instrumented, non-towered facilities**
  - **Lower landing minimums at minimally equipped landing facilities**
  - **Increase single pilot crew safety mission reliability**
  - **En route procedures and systems for integrated fleet operations**

# What is the Airborne Internet?

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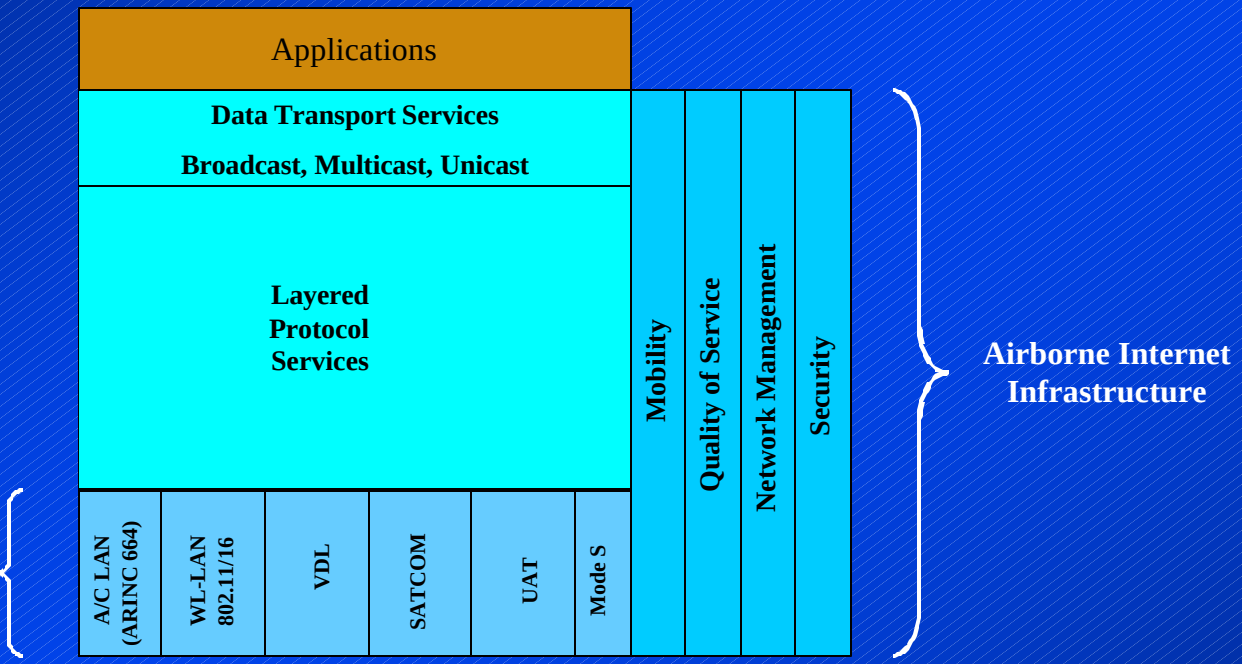
## Generic SATS AI Model




- **An Integrated CNS approach to interoperability - all services through a common communications methods.**
- **All the challenges that the ATN faced in the 1980's, but using the standards of today.**

# Airborne Internet Notional Diagram[1]

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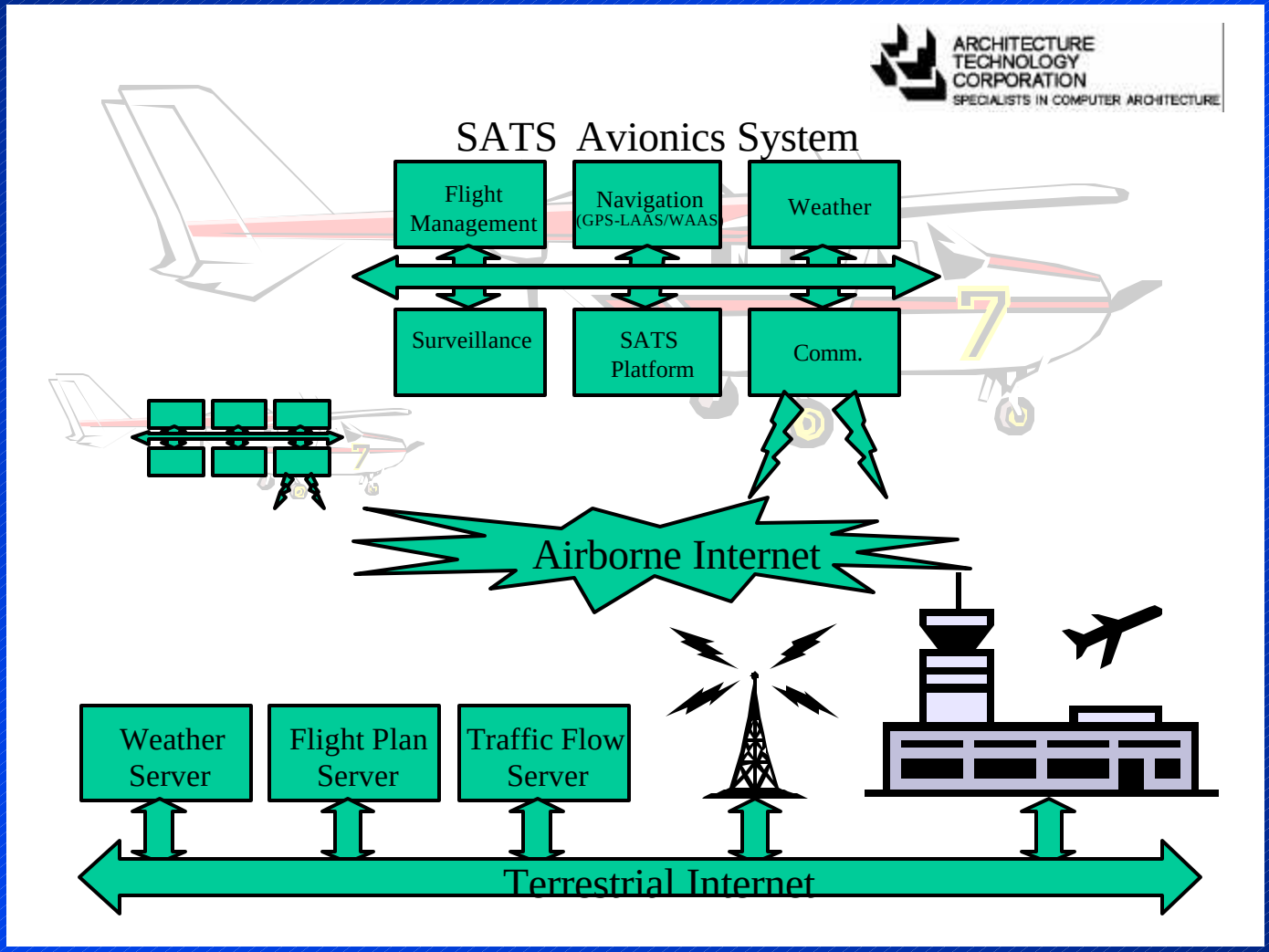


1. Source: SATS Airborne Internet Joint Meeting ATC/CNS, Architecture Technology Corporation Briefing, 3/1/02.

# *What did we do?*

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- **Preliminary Concept of Operations**
- **AI Requirements Definition**
- **CNS Technology evaluation/tradeoff**
- **Study of NAS evolution and SATS synchronization issues**
- **Defined three candidate architectural approaches:**
  - **Ground Centric ( M3 and UMTS - Cellular)**
  - **Space Centric (Immarsat)**
  - **Air Centric (Mode SATS)**
- **Performed Architecture Assessment**
- **Set-up a Testbed for the Mode SATS Approach**

# *What is Mode SATS*

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- **Based upon Self-Organizing VHF Data Link using GFSK modulation (peer-to peer technique).**
- **Builds upon the core ICAO navigation-surveillance standards for VHF datalink.**
- **Allows aircraft-to-aircraft switching (ad hoc networks) for AI communications.**
- **Single channel data burst rate is 19.2 Kbps.**
  - **Significant data throughput improvements through wide-band or multichannel techniques.**
- **Frequency tuning range:**
  - **Today - 108-137 MHz**
  - **Researching 330MHz or higher usage**

# CNS SATS Airborne Internet Environment

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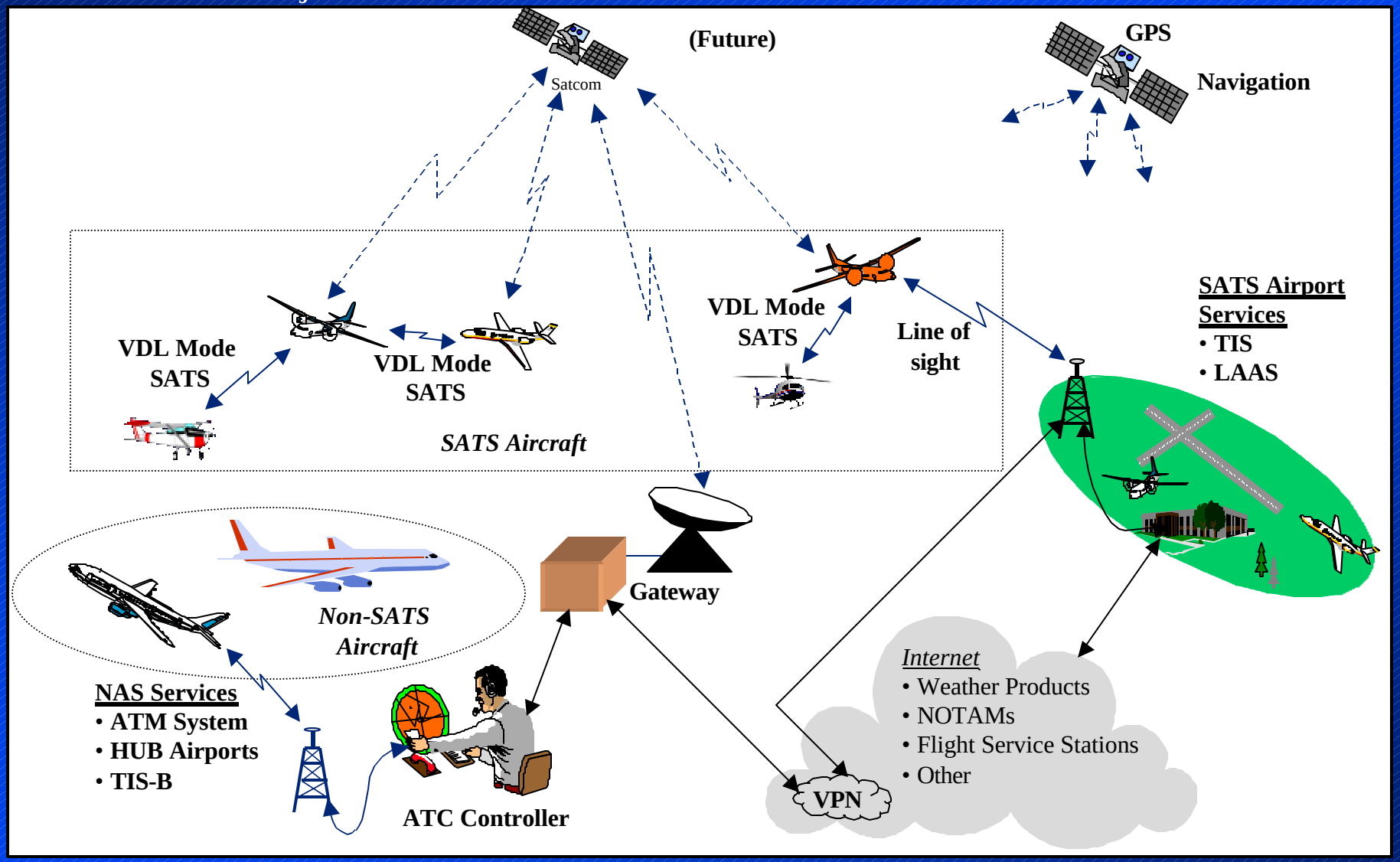

# Tell me About the Testbed

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## AI Testbed Objectives - Build A

- **Provide a 'Hands-on" technical platform to assess the principles and design of the Airborne Internet concept.**
- **Provide an affordable platform using COTS products.**
- **Provide base for additional technology insertion.**

### *Architectural Principles*

| Ref | Principle |
|---|---|
| 1 | Provides the means to fully support the functional services. |
| 2 | The AI will be separable into platform specific systems defined as the CMS and a system defined as the NMS. To this extent the architecture will modular. |
| 3 | The mechanisms and techniques employed with the AI will be self-organizing. |
| 4 | All communication (to the extent practical) will be performed through a primary means of communication. |
| 5 | The system will be constructed using open system standards. |
| 6 | The interface to the NAS (enroute, terminal controllers) will be through a gateway facility. |
| 7 | Provide for interfaces to the entities shown in the Entity relationship Model. |
| 8 | Provide for information and operational security. |

| Installed Technology | |
|---|---|
| VHF Data Link (air-centric Mode SATS) | √ |
| TCP/IP | √ |
| Peer-to-Peer (connectivity) | √ |
| Emulated SATS Applications<br>▪ ADS-B, ATN CPDLC, FIS-B graphical weather, Pilot/Aircraft information exchange, and email | √ |
| Scalable | √ |

# Test Bed – Build A with Mode SATS

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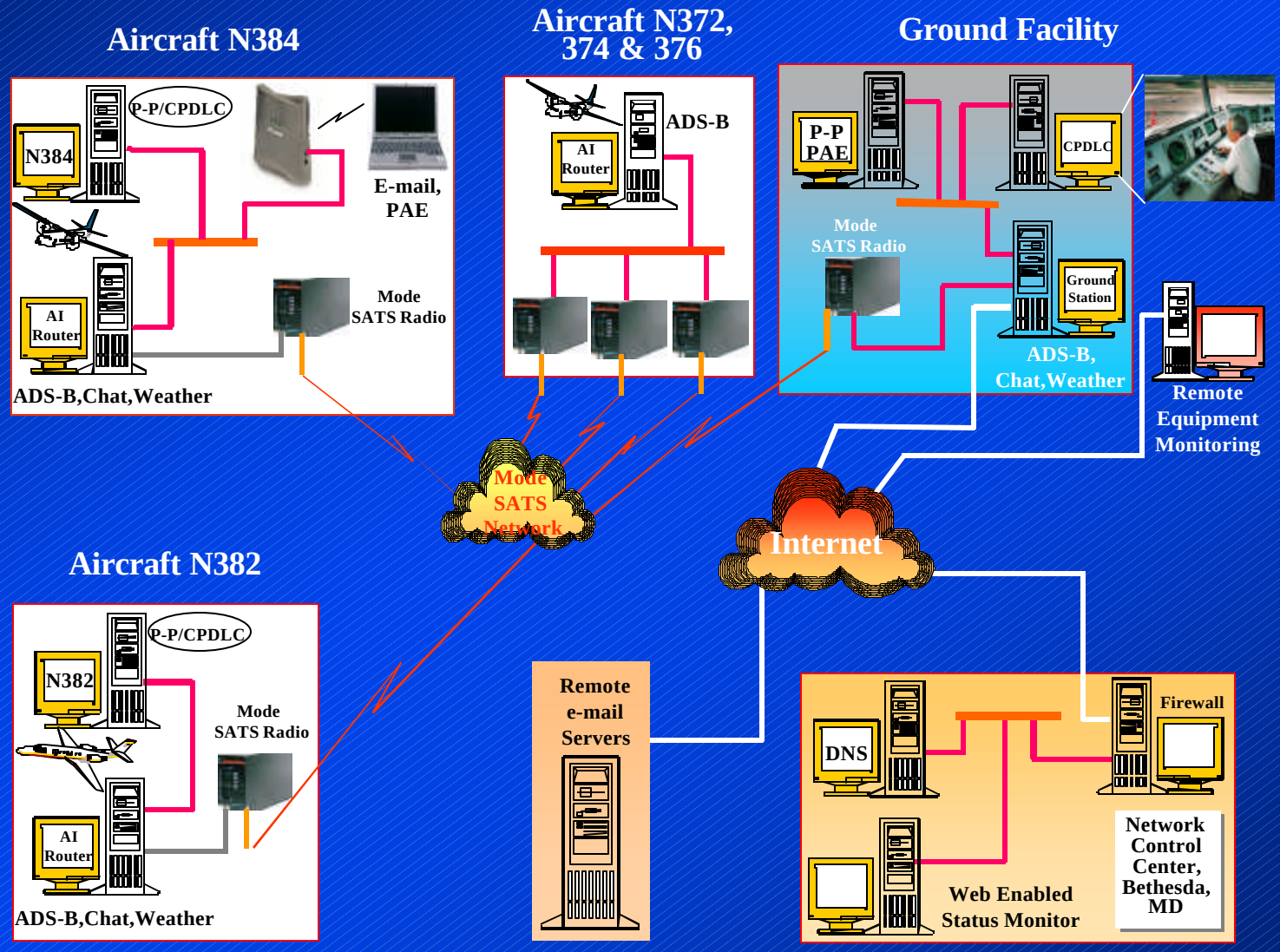

# SATS Nodal Protocol Architecture

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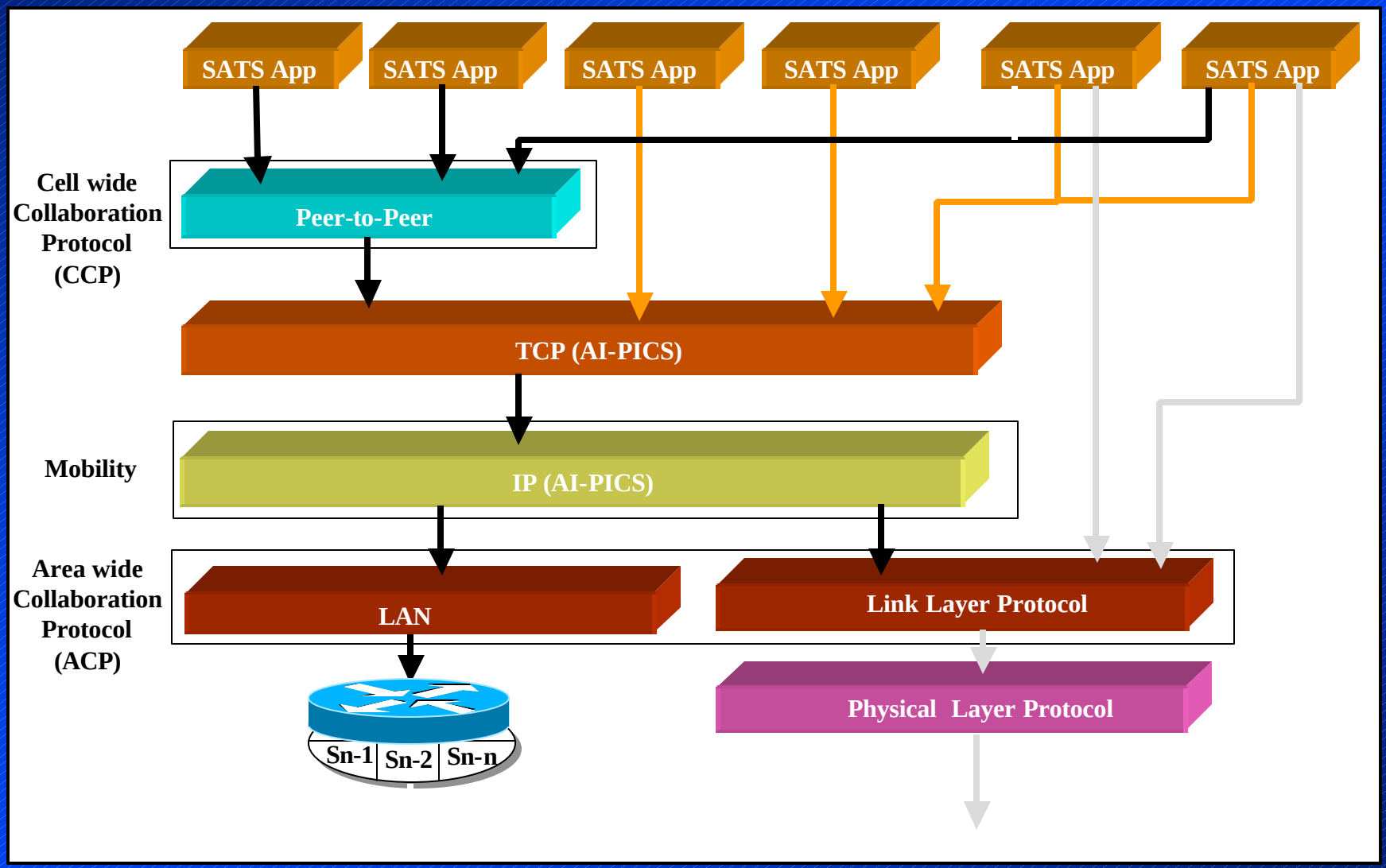

# *Demonstration Scenarios*

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- **ADS-B**
- **Air-Air Chat**
- **FIS-B Graphical Weather**
- **Browsers to Access the Internet**
- **Streaming Video**
- **CPDLC**
- **Email**
- **Remote Monitoring Equipment Status**

# Test Bed – Build A with Mode SATS

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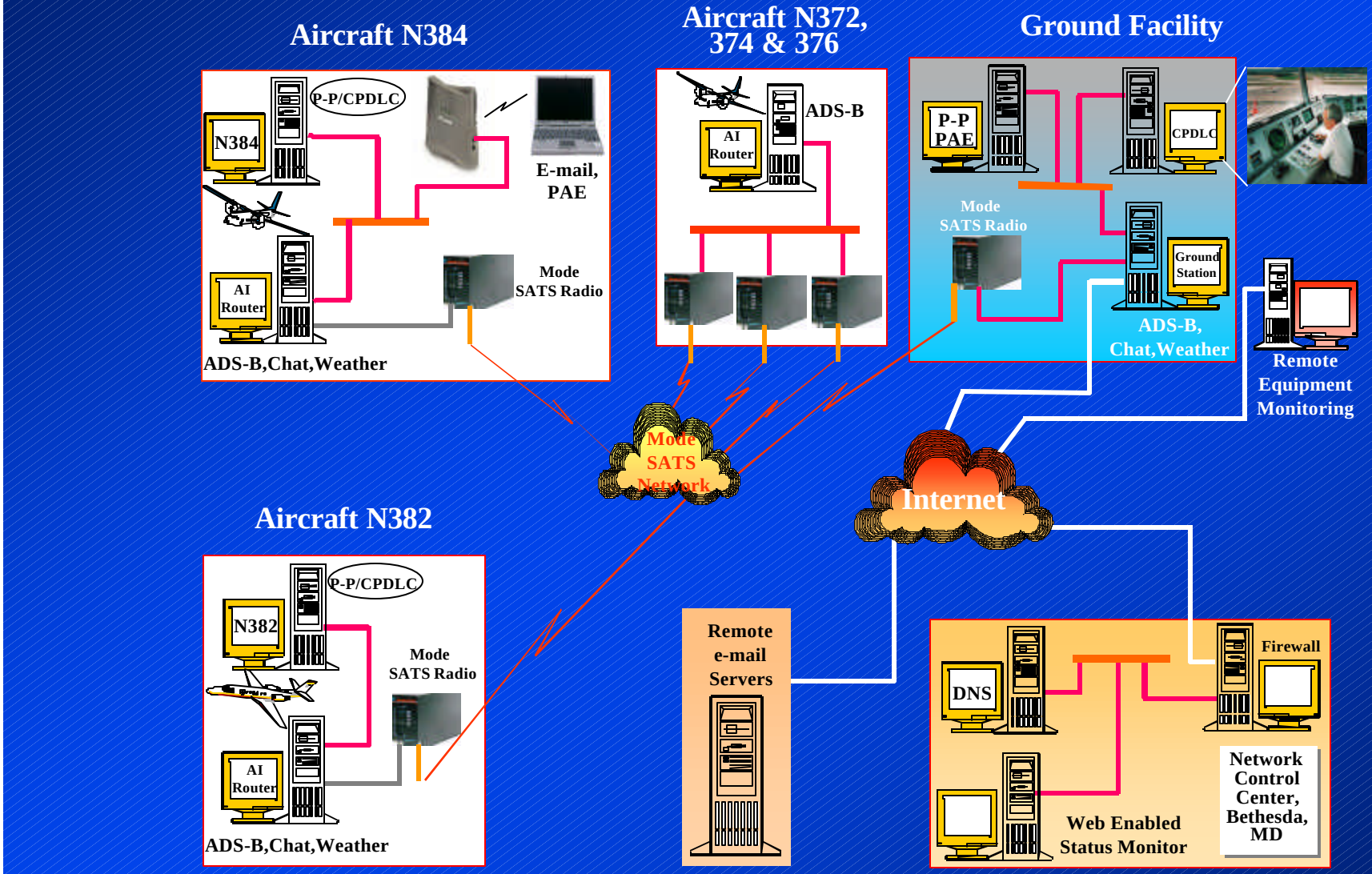

# Reference for Handout

# Evaluation Factors and Architecture Models

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### *Evaluation Factors*

- Cost
  - On-board and off-board cost components
  - Infrastructure requirements
  - Overlay on existing or new infrastructure to support SATS AI
  - SATS dedicated infrastructure or shared (and paid for) by other users
  - Use of airport area as cost model
- Availability
  - Time horizon
- Performance
  - Adherence to AI architectural principles
  - Functional requirements
  - Bandwidth sizing
  - Reliability – redundancy
  - Delay
- Scalability
- Risk Assessment

### *Candidate Architectures for Comparison*

| Technology | Space | Air | Ground |
|---|---|---|---|
| Inmarsat INM 3 & 4 | √ | | |
| VDL Mode SATS | | √ | |
| UMTS for ATC | | | √ |
| 3 GPP | | | √ |
| TCP/IP, Mobile IP, Multicast | √ | √ | √ |
| TIS-B, LAAS | √ | √ | √ |
| Peer-to-Peer | √ | √ | √ |
| Self Organizing (Manet) | | √ | |
| CDMA | | | √ |
| IPSec | √ | √ | √ |

# AI Architectural Evaluation Results

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- **Aircraft Centric Architecture**
  - **Meets SATS requirements**
  - **Low risk, low cost, near COTS option**
  - **ICAO standards based with multiple hardware vendors**
- **Space Centric Architecture**
  - **Available as a service now**
  - **Existing aircraft can be upgraded to this service**
  - **Transition higher bandwidth with Inmarsat-4 constellation**
- **Ground Centric Architecture**
  - **UMTS technology has no inherent show stoppers and meets SATS requirements**
  - **High risk - dependence on commercial aviation for development, certification and deployment of technology**

**Aircraft - centric currently evaluated as best approach.**

# Information (Data) Transfer Scheme

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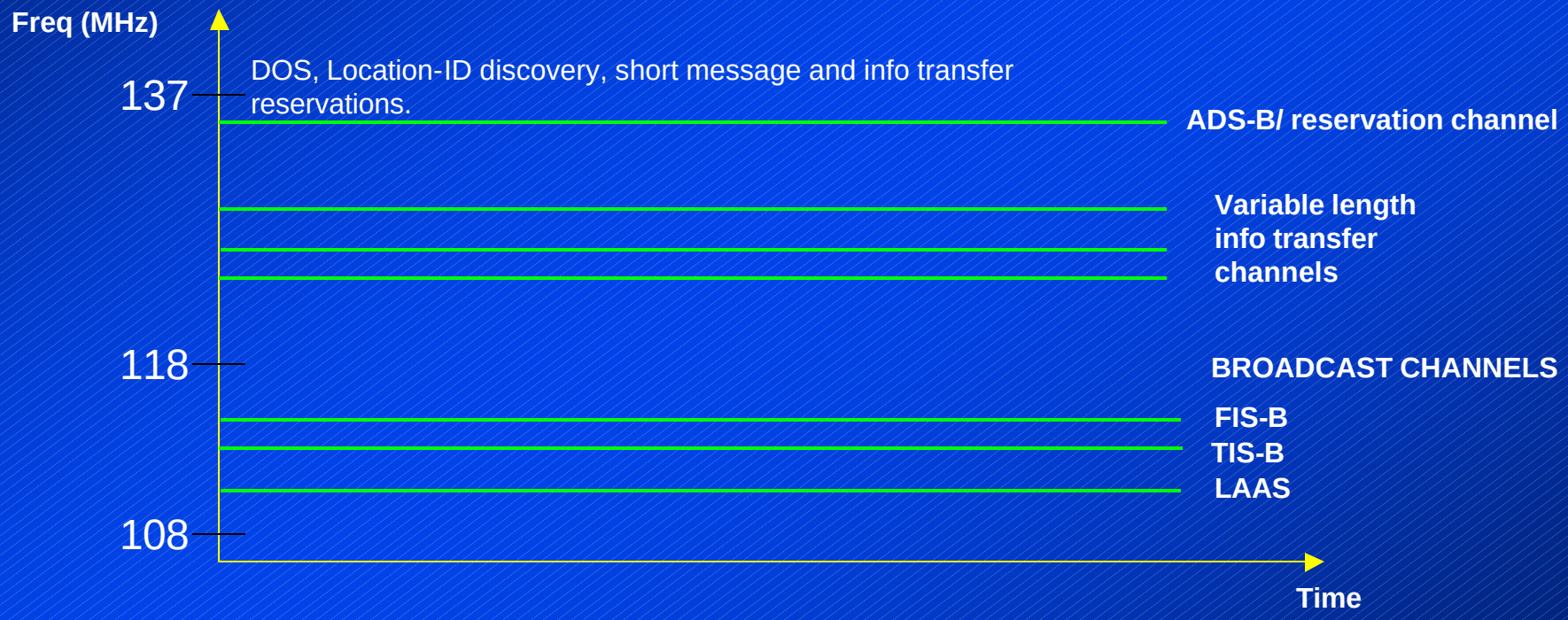
| | |
|---|---|
| **Test mode:** | **Development and testing by use of multiple-mode VHF 25 KHz hardware.** |
| **Operational mode:** | **One wide-band with priority based TDMA channelization or multiple narrow band channels dynamically assignable to meet requirement.** |




**Note:** Minimum equipage required is frequency agile avionics with 2 receivers + 1 transmitter

# Airborne Internet Build A Summary

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- **VDL Mode SATS point-to-point and broadcast communication capability:**
  - **Air-to-air, self organizing, peer-to-peer communication**
  - **Functionality/interoperability**
- **Demonstrated "all-in-one" AI connectivity.**
- **Internet connectivity.**
- **Integrated hardware/software components from many suppliers.**
- **Successfully implemented and tested the software based router for SATS AI.**

| Integrated Components |
|---|
| Mode SATS VHF Radio |
| EFR 300 Ground Station |
| VDL Mode Subnet Emulation using RF Attenuator |
| ADS-B Position Reporting System |
| FIS-B Graphical Weather Products |
| ATN CPDLC |
| Pilot/Aircraft Information Exchange |
| Netscape |
| E-mail Application |
| Web-enabled Remote Equipment Status Monitor |
| Aircraft Mobility Based on DNS |
| Peer to Peer tool |
| Intel-based Workstations and Sun Workstations (Ultra 10) |

**Configuration and integration work represents a "one of a kind" rapid prototype of the airborne internet.**

# *Contacts*

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